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(56) Documents Cited
EP 0629481 A1 EP 0145812 A2
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US 4386989 A

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(54) Abstract Title
Mechanical contact apparatus and a method of production

(57) Apparatus for responding to a mechanical contact applied thereto is described and preferably takes the form of a keyboard. The apparatus is substantially flat, flexible and foldable and is constructed from many component layers wherein a least one of the component layers is a textile fabric. A moulded outer edge is provided for constraining unfinished edges of these layers. The edge may be moulded from an elastomeric material such as silicone rubber, polyurethane and other thermoplastics.

The moulded edge is formed by locating the unfinished edges of an assembly of layers in a mould cavity 402 in which the elastomeric material may preferably be injected to encapsulate the unfinished edges.

The edges of the mould apply compression to the textile fabric.

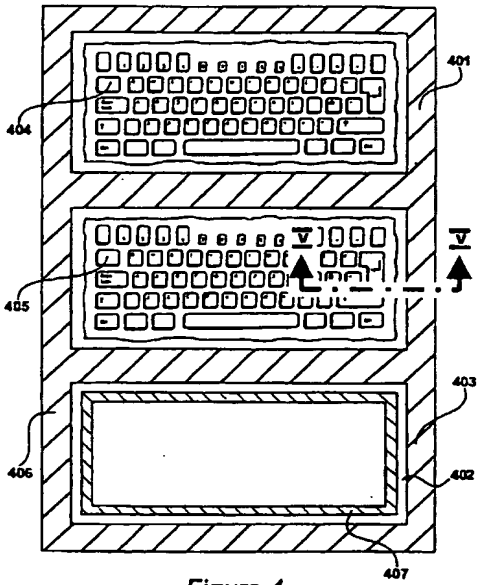

Figure 4

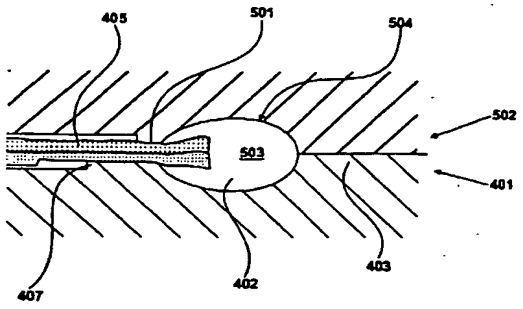

Figure 5

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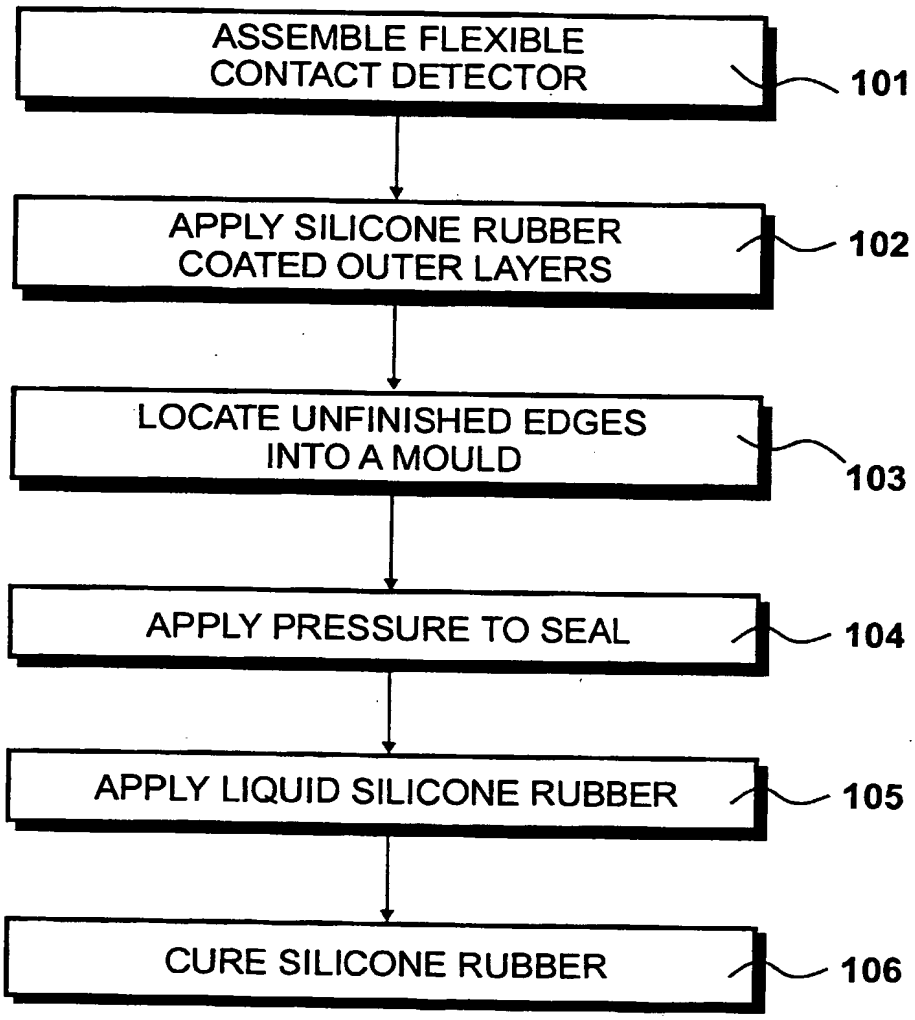

Figure 1

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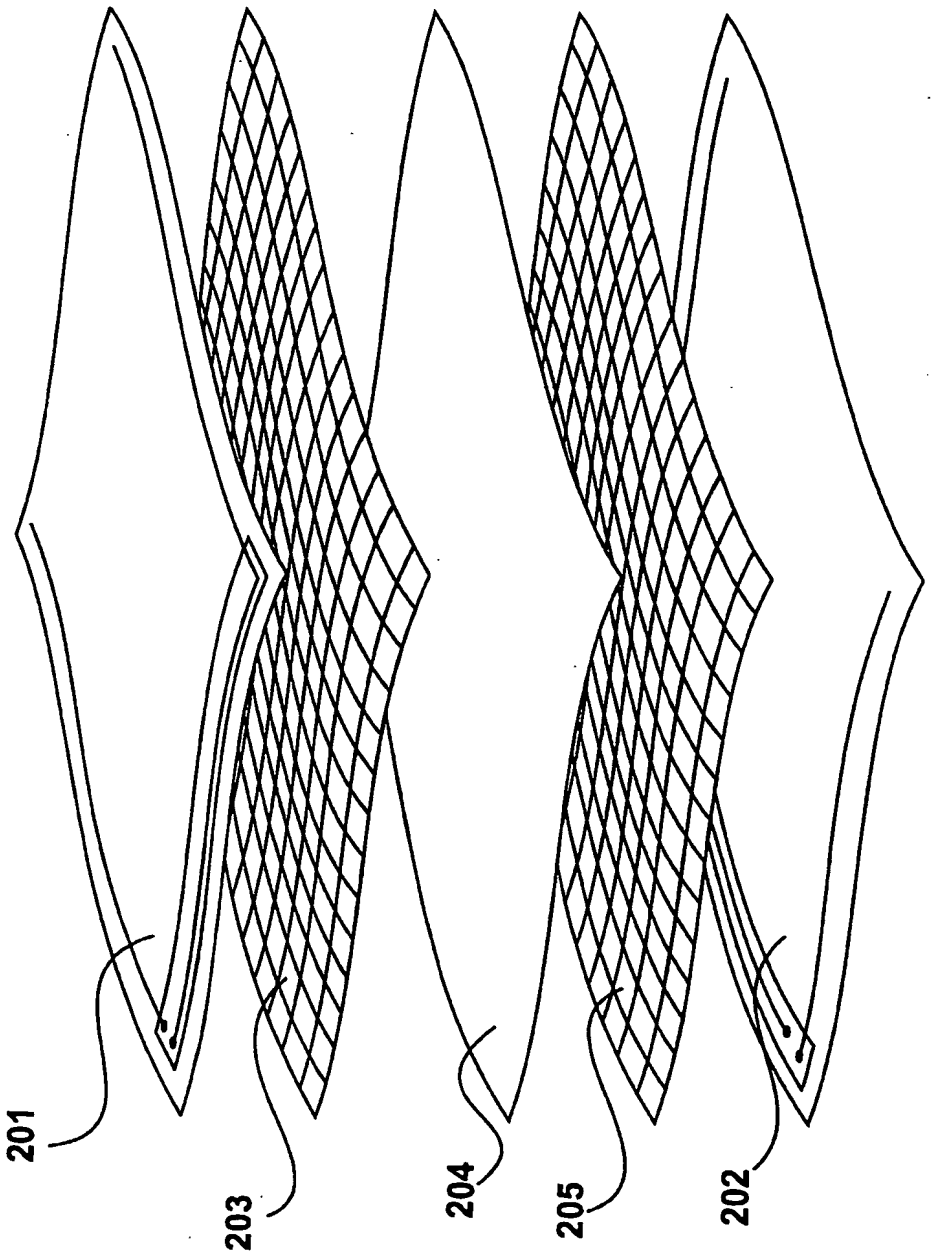

Figure 2

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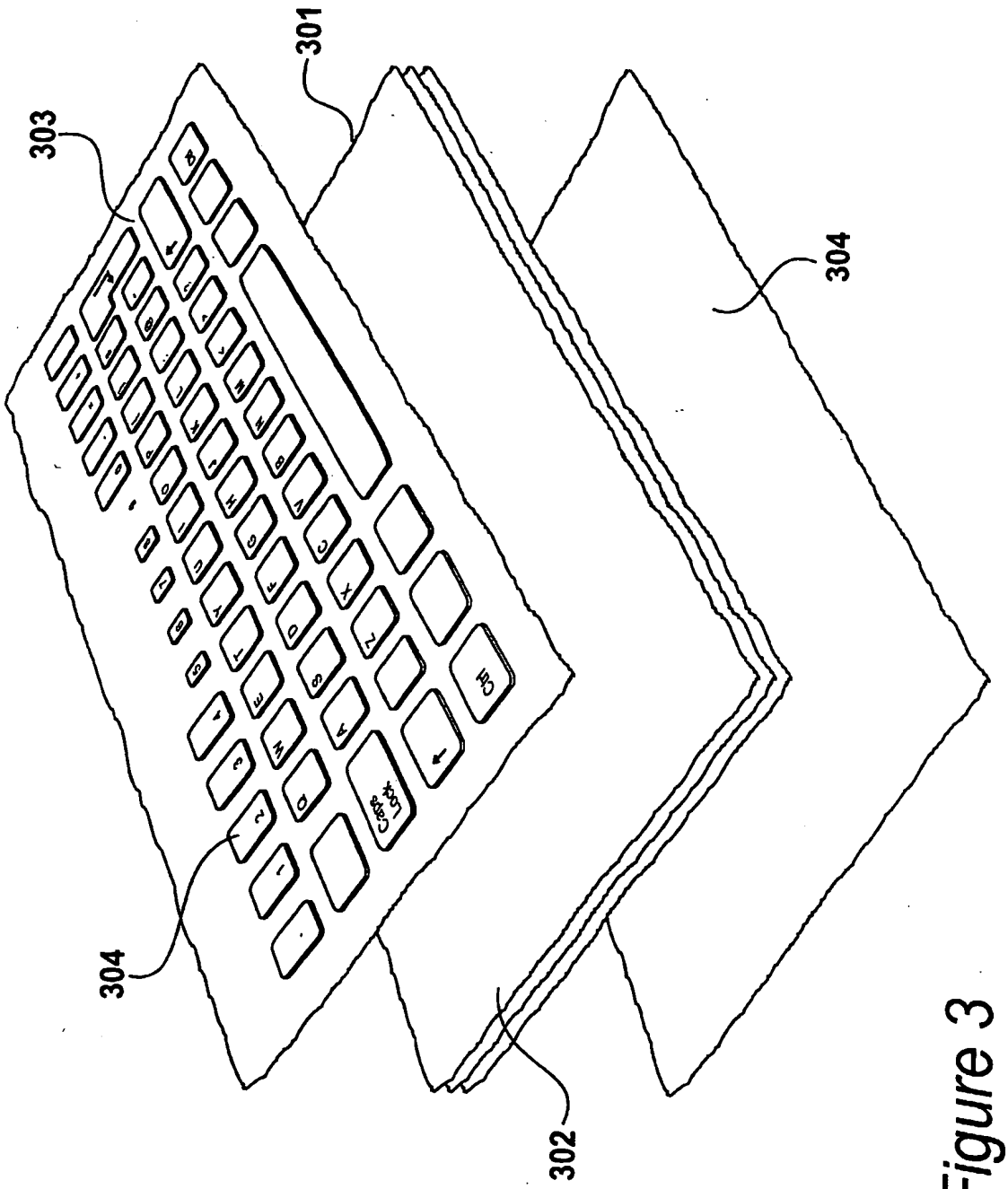

Figure 3

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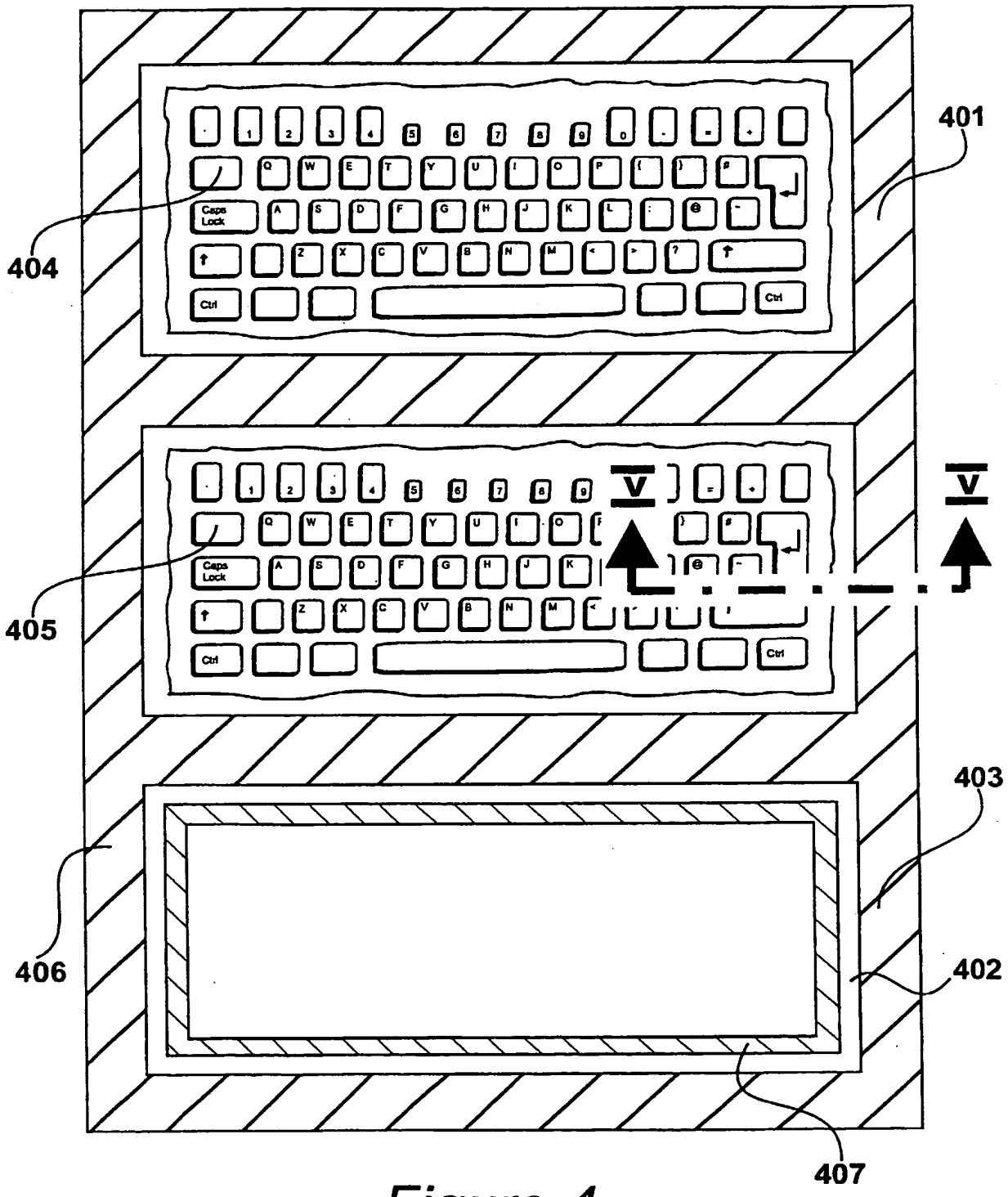

Figure 4

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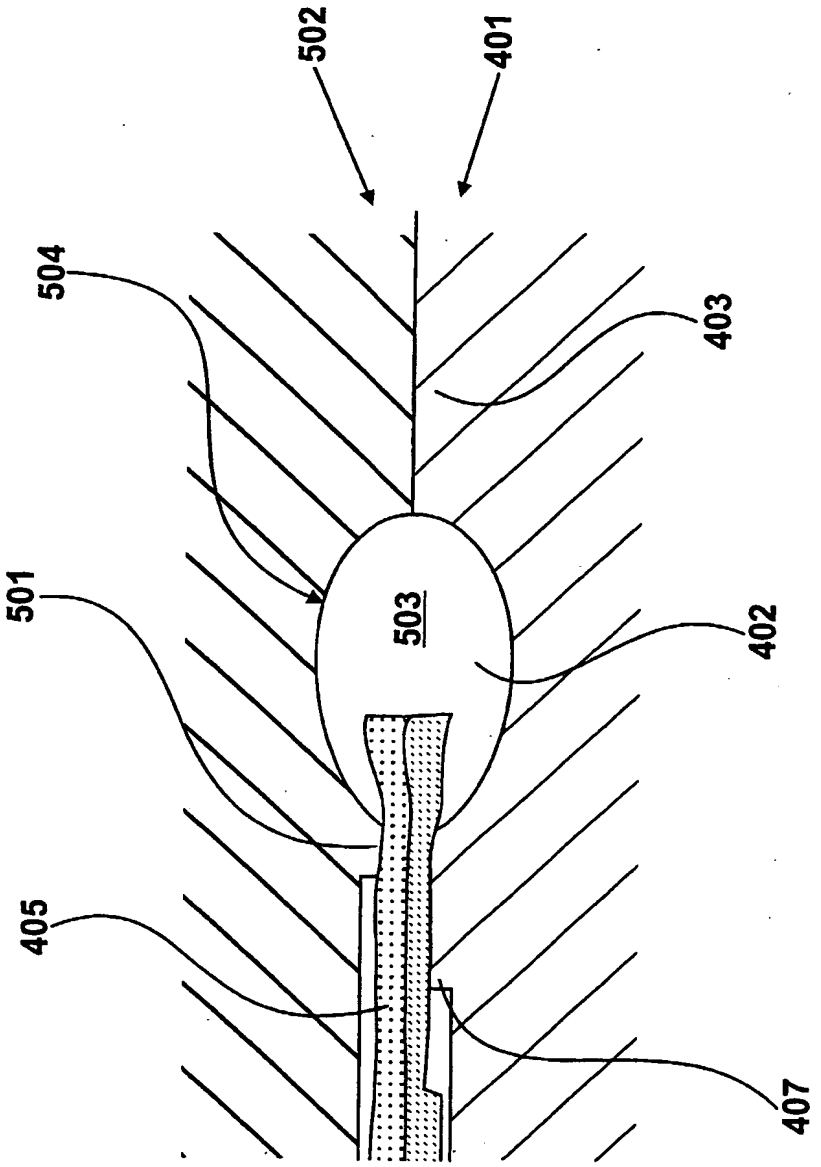

Figure 5

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6/6

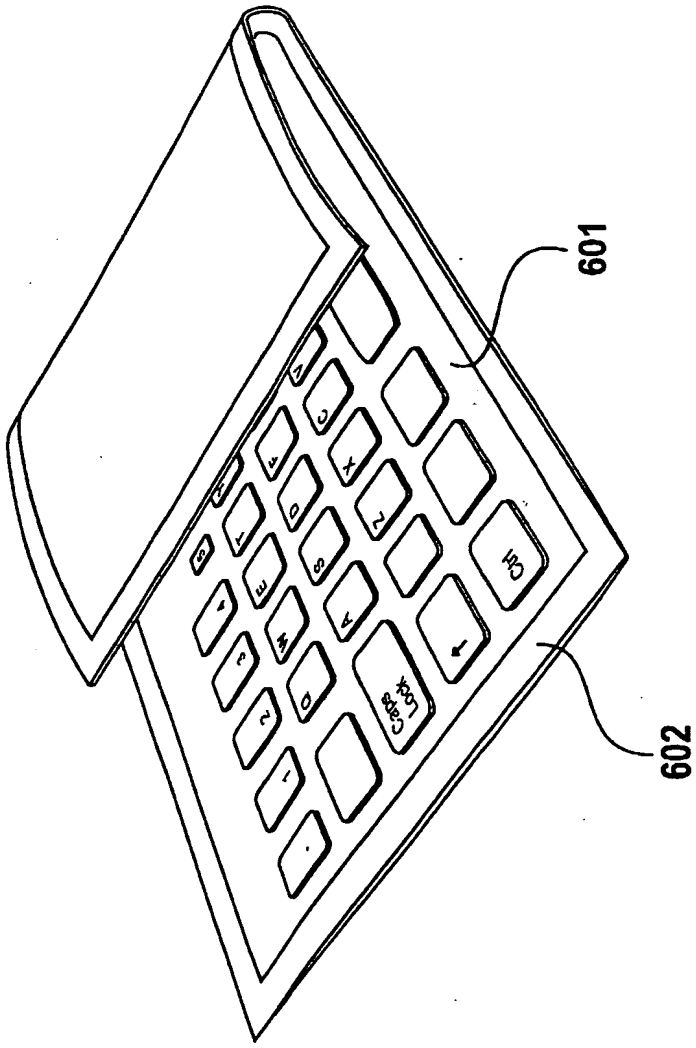

Figure 6

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Mechanical Contact Apparatus and a Method of Production

The present invention relates to a method of producing apparatus arranged to respond to mechanical contact applied thereto.

A position detector using foldable fabric is described in international patent publication WO 00/72239, the contents of which is incorporated herein by reference. A position detector is also described in co-pending United States patent application 09/744,155 and again the contents of this application are incorporated herein by reference.

A problem with using fabric layers to produce a detector, or any other similar device, is that the edges of the fabric are prone to fraying and as such measures must be taken to finish off the edges of the device. Conventionally, fabric materials are finished off by a process of hemming and sewing in order to produce a clean edge. Alternatively, it is also known to use gluing techniques. Both of these known techniques require sophisticated operations to be performed such that mass production procedures become complicated and therefore expensive.

According to an aspect of the present invention, there is provided a method of producing apparatus arranged to respond to mechanical contact applied thereto, comprising the steps of: assembling a substantially flat flexible and foldable mechanical contact detector from a plurality of component layers, wherein at least one of said component layers is a textile fabric and, said assembled detector has unfinished edges; locating said unfinished edges of said assembled detector in a mould, wherein edges of said mould apply compression to said textile fabric; and applying liquid material to said mould so as to encapsulate said unfinished edges.

The invention will now be described by way of example only with reference to the corresponding drawings, of which:

Figure 1 shows procedures for producing an apparatus arranged to respond to mechanical contact;

Figure 2 details the step of assembling a contact detector.;

Figure 3 details the step of applying outer layers;

Figure 4 details the moulding of an edge for the detector;

Figure 5 details the cross section identified in *Figure 4*;

Figure 6 shows a finished example of the apparatus;

Figure 1

Procedures for producing an apparatus arranged to respond to mechanical contact are shown in *Figure 1*. At step **101** a flexible contact detector is assembled from a plurality of fabric layers. In a preferred embodiment, the nature of the detector is substantially as described in the aforesaid international patent publication WO 00/72239 assigned to the present Assignee. However, other configurations of detector could benefit from the present invention. For example, the invention could be used with a flexible circuit type detector.

After the flexible detector has been assembled at step **101**, outer layers are applied at step **102**. These outer layers each consist of a fabric layer having a silicone rubber layer cured thereon. The presence of the silicone rubber ensures that the detector is water resistant. In addition, if the contact detector is being used to provide basis for a flexible keyboard, for example, indentations identifying the location of specific keys may be moulded into one of the silicone rubber layers.

At step **103** unfinished edges of the detector assembly are located into a mould. Thereafter, at step **104** pressure is applied to the mould in order to provide a seal around its edges. In particular, the fabric layer or layers are placed into compression.

At step **105** liquid silicone rubber is applied into the mould and at step **106** the silicone rubber is cured so as to present a solid elastomer forming the outer edge. Consequently, the unfinished edges of the detector are encapsulated within the silicone rubber, which presents a tidy finished edge to the apparatus. Furthermore, the procedure achieves a high level of repeatability, making it suitable for scaling-up for mass production. Silicone rubber has particular benefits for this application but other elastomeric materials could be used, such as polyurethane, TPE and other thermoplastics etc.

Figure 2

Step **101** for the assembly of the flexible contact detector is detailed in *Figure 2*. The detector assembly consists of a first outer conducting layer **201** and a second outer conducting layer **202**. Sandwiched between said outer conducting layer **201**, **202** are a first insulating layer **203**, a central conducting layer **204** and a second insulating layer **205**. In use, a potential gradient is created across outer layer **201**. Contact results in a voltage being detectable at layer **202**. Furthermore, a determination of current allow the extent of the contact to be determined. False triggering of the device is inhibited because folding may result in contact being created between layer **201** and layer **204** or between **204** and layer **202**. However, it is difficult for folding to create contact between layer **201** and **202** such that a false triggering event is

unlikely to occur.

Figure 3

Step **102**, for the application of the silicone rubber coated outer layers to the detector, are illustrated in *Figure 3*. In this example, the fabric contact detector forms a basis for a manually operable keyboard of the type that may interface to a hand held computing platform, such as that described in international patent application WO 01/75572, equivalent to United States patent application number 09/980,236, both of which are incorporated herein by reference. Alternatively, the keyboard may be interfaced to a mobile telephone as described in co-pending British patent application (P141). Similarly, keyboards of this type may be interfaced into any device requiring manual data input.

An alternative embodiment to using a fabric keyboard is described in international patent publication WO 01/75572, the contents of which is incorporated herein by reference. A similar disclosure is also included in co-pending United States patent application number 09/980,236, the contents of which is also included herein by reference. In the alternative embodiment, the keyboard is a membrane keyboard having an uppermost layer of silicone rubber. This silicone rubber layer is laminated on its upper surface with a durable fabric layer onto which graphical icons and alpha numerics are printed. Alternatively, the uppermost layer is laminated with a durable flexible plastic film, such as a film of polyester or polyvinylchloride, onto which the graphics etc have been printed.

The alternative membrane keyboard includes a first electrically

conductive membrane film and a second electrically conductive membrane film. In addition, a spacing membrane layer is positioned between the first electrically conductive membrane layer and the second electrically conductive membrane layer.

The first electrically conductive membrane layer is a film of MYLAR (polyethylene terephthalate. Electrodes are printed onto the underside of the film thereby forming a conductivity channel for the first electrically conductive membrane. The electrodes are connected to an interface circuit that supplies voltages to these electrodes via conductive tracks. Each electrode is specifically aligned so as to correspond with a key registration device on the outermost layer.

The second electrically conductive membrane layer is also composed of a MYLAR membrane having electrodes printed thereon. Each of the electrodes printed onto the upper surface layer is aligned with a corresponding electrode on the co-operating layer and a corresponding key registration device on the outermost layer.

A separator layer is provided in the form of a non-conductive membrane sheet of MYLAR with holes located to coincide with the positions of the co-operating electrodes. The separator layer prevents electrical contact occurring between the electrodes of the layers unless a mechanical interaction has occurred by the pressing of a specific key. Alternatively, the membrane layers may be made of alternative plastics materials.

The layers illustrated in *Figure 2* are brought together to provide an assembled flexible contact detector **301**. This assembled contact detector

has unfinished edges **302** requiring a finishing operation to be performed. An upper surface layer **303** consists of an outer fabric layer supported by a silicone rubber layer, wherein the silicone rubber is sealed to the fabric layer during a curing process. During the curing process, pressure is applied to bring the layers together and to introduce three dimensional key positions **304** into the composite upper surface layer.

A lower surface layer **304** provides a base for the material. In order to ensure that the whole of the device is water resistant, in this embodiment the lower surface layer also has silicone rubber on its upper surface which becomes cured by the use of heat to form a bond with the upper surface **303**. Consequently, the upper surface layer composite **303**, the central flexible contact detector **301** and the lower surface layer composite **304** are brought together to produce an operational apparatus with unfinished edges.

Figure 4

The operational apparatus with unfinished edges is located into a mould as identified at step **103** and as detailed in *Figure 4*.

The mould consists of two portions, namely a lower portion **401** and a co-operating upper portion. Mould **401** defines a channel **402** into which silicone rubber is received during the moulding process.

In the plan view of the mould shown in *Figure 4*, three unfinished operational apparatus (keyboards in this example) are receivable in the mould. In the example shown in *Figure 4*, a first keyboard **404** has been received within the mould, a second keyboard **405** has been received within the mould and a third keyboard is about to be introduced. An outer contact region **406** contacts with a co-operating region of the upper portion so as to

form a seal. Inner raised region **407** co-operates with a similar region on the upper portion and presses firmly against the operational assembly. In particular, inner region **407** applies compressive force to the fabric layers.

After three keyboards have been introduced into the lower portion of the mould, the upper portion of the mould is lowered into position and a pre-determined force is applied to the two portions so as to achieve a seal at portion **406**. The spacing above the "pinch" portion **407** should ensure that the keyboards are held firmly so as to prevent the seepage of liquid silicone rubber but should not be too small such that the operational apparatus is compressed too tightly so as to ensure no damage is caused to the detector layers.

It should be appreciated that the inclusion of three devices within the mould is merely an example. More devices could be included in each mould or, alternatively, a continuous process could be developed.

In an alternative mould construction, an elastomeric gasket is included within portion **407** to facilitate the correct level of compression, even when different thickness layers are used.

Figure 5

A cross section on line v-v is shown in *Figure 5*. In the lower mould portion **401** keyboard **405** is supported by raised portion **407**. This co-operates with a similar raised portion **501** in upper mould portion **502**. Liquid silicone rubber is received within void **503**, defined by region **402** of the lower mould portion **401** in combination with portion **504** of the upper mould portion **502**.

The silicone rubber injected into void **503** is selected so as to be compatible with silicone rubbers used for the production of the keyboard **505**. Preferably, the silicone rubber selected vulcanises at room temperature and the curing process is facilitated by heating the upper and lower mould portions **502**, **401** and by raising them to an operating temperature of, typically, between fifty and one hundred and fifty degrees centigrade. After being injected into void **503**, the silicone rubber is left to cure for approximately two minutes, whereafter the upper mould portion **502** is raised and the cured articles are removed, thereby allowing the process to be repeated.

Figure 6

After the cured articles have been removed from the mould, edges of the article are trimmed as identified at step **107**.

The finished keyboard is shown in *Figure 6* in which an operational area **601** is surrounded by a moulded bead **602** produced by the process previously described.

In an alternative embodiment, the tools may be provided with a "tear seal" feature so as to facilitate the trimming of the external edge.

Claims:

1. A method of producing apparatus arranged to respond to mechanical contact applied thereto, comprising the steps of:

assembling a substantially flat flexible and foldable mechanical contact detector from a plurality of component layers, wherein at least one of said component layers is a textile fabric, wherein said assembled detector has unfinished edges

locating said unfinished edges of said assembled detector in a mould, wherein edges of said mould apply compression to said textile fabric; and

applying liquid material to said mould so as to encapsulate said unfinished edges.

2. A method according to claim **1**, wherein said applied liquid material sets to form a solid elastomeric material.

3. A method according to claim **2**, wherein said elastomeric material is silicone rubber.

4. A method according to claim **3**, wherein said silicone rubber is room temperature vulcanising silicone rubber.

5. A method according to claim **2**, wherein heat is applied to said mould to encourage the solidification

6. A method according to any of claims 1 to 5, wherein said apparatus is a keyboard configured to respond to mechanical contact.

7. A method according to claim **6**, wherein said keyboard is flexible.

8. A method according to claim **7**, wherein said flexible keyboard is constructed predominantly from fabric.

9. Apparatus arranged to respond to a mechanical contact applied thereto, said apparatus comprising

substantially flat flexible and foldable mechanical contact detection means, constructed from a plurality of component layers wherein at least one of said component layers is a textile fabric; and

a moulded outer edge wherein unfinished edges of said layers are constrained within said moulded edge.

10. Apparatus according to claim **9**, wherein said edge is moulded from an elastomeric material.

11. Apparatus according to claim **10**, wherein said elastomeric material is silicone rubber.

12. Apparatus according to claim **11**, wherein said silicone rubber is room temperature vulcanising silicone rubber.

13. apparatus substantially as herein described with reference to the accompanying drawings.

14. A method of producing apparatus arranged to respond to mechanical contact applied thereto, substantially as herein described with reference to the accompanying drawings.

INVESTOR IN PEOPLE

Application No: GB 0212081.4 **Examiner:** Monty Siddique
Claims searched: 1-14 **Date of search:** 27 November 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B5A (AB12, AB13, AB19, AB2, AB3)

Int Cl (Ed.7): B29C 39/10 41/20 45/14 70/76; G06K 11/12 11/18

Other: Online: WPI EPODOC JAOPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	EP 0629481 A1	(FACCHINETTI) covering the edge of a fabric by moulding; figure 6	1, 9 at least
Y	EP 0145812 A2	(ORREUS) encapsulating unfinished edges of cloth by moulding	1, 2, 9 at least
Y	WO 2000/072239 A1	(ELECTROTEXTILES COMPANY) apparatus of the type to which the present invention relates, claim 28 etc.	1, 2, 9 at least
Y	DE 3712882 A1	(SCHAEFFLER) encapsulating the edges of a fabric by plastics	1, 2, 9 at least
Y	US 4386989	(SOCIETE NATIONALE...) encapsulating edges of fabrics by moulding	1, 2, 9 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.